

The image is a composite graphic. At the top right, a satellite with solar panels is shown in space. A large, semi-transparent blue triangle originates from the satellite and points downwards, covering the upper half of the image. In the center, a solar glider with long, thin wings and a small tail is flying over a landscape. Below the glider, a network of ground-based towers is connected by a grid of blue lines, representing a terrestrial network. The background shows a view of Earth from space, with the horizon and atmosphere visible. The overall theme is the integration of satellite, aerial, and terrestrial networks.

HAPS Alliance

HIGH ALTITUDE PLATFORM STATION

A Framework for Coexisting Terrestrial-Aerial-Satellite Networks

May 2026

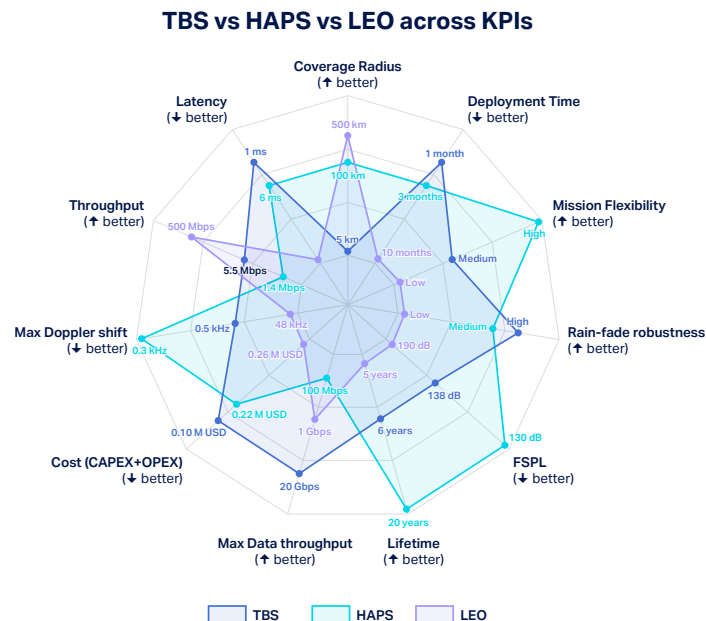
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Executive Summary

Global connectivity is a dream whose realization lies in the interplay of numerous key players. The traditional terrestrial and satellite communication infrastructures, though instrumental, have their own limitations. For instance, Low Earth Orbit (LEO) satellite communications face challenges like high latency compared to aerial/terrestrial systems, network saturation/congestion, spectrum crowding, frequent handovers, high Doppler, user terminal constraints, and a finite, non-serviceable on-orbit lifespan (typically 5–10 years before de-orbiting, with limited in-life payload upgrade options). On the other hand, terrestrial networks face limited footprint, terrain blockages, costly expansion/scalability, inflexible deployment, backhaul constraints, operational rigidity, and labor-intensive RAN equipment upgrades at remote rural sites that require specialist tower-climbing crews.

High-Altitude Platform Stations (HAPS), often referred to as “cell towers in the sky,” operating in the stratosphere (~20km) can address numerous limitations in terrestrial and satellite communications [1]. They are superior to terrestrial infrastructure in features such as a larger coverage area, flexible deployment (e.g., to handle flash crowds), short-range line-of-sight links, resilience to certain natural disasters, seamless highway connectivity, and economical sparse coverage. HAPS are advantageous over satellites due to favorable channel conditions, quasi-stationary positions with fewer handovers, lower round-trip delay, smaller footprint, higher area throughput, ease of maintenance/reusability, surge coverage, and direct-to-standard handsets [2]. They are particularly superior for their dynamic, flexible deployment. They can reposition themselves (a) horizontally as per user demands, towards the town center during the day and towards residential areas during the night, and (b) vertically to adjust the capacity-vs-coverage tradeoffs.



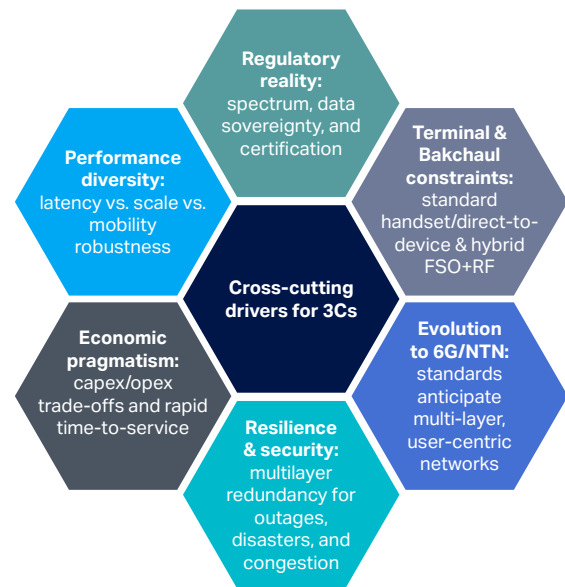
Despite the satellite proliferation, HAPS are still relevant for the following major reasons:

1. They are proven to be an **economical coverage solution** for underserved/unserved areas with no requirement for specialized user equipment. The CapEx and OpEx estimations reveal the viability of HAPS for regional coverage [3].
2. They offer a green solution with a **lifespan of 20 years** as opposed to the satellite lifetime of 5-8 years, after which it becomes space debris.
3. **Direct-to-device connectivity and relatively shorter path** to the ground users allows for seamless higher throughput services¹ (such as voice/video calls, HD/4K streaming, cloud gaming, augmented/virtual/extended reality (AR/VR/XR), and other real-time services including telemedicine, remote learning, live collaborations etc.), rather than low bandwidth services e.g., text messaging and SOS calls. Although this example concerns fixed-wireless access (FWA) rather than direct-to-device (D2D) links, recent experience with Starlink's FWA service in Kenya has highlighted high equipment and subscription costs and capacity-driven freezes on new sign-ups in dense urban areas, highlighting that LEO-based broadband can become expensive and congested in markets where HAPS can provide more flexible, targeted coverage ²

Some key KPIs are selected for radar comparison of terrestrial BS (TBS), HAPS, and LEO; a more detailed comparison is provided in [4]. Considering uneven user demand across space/time, infrastructure limitations, economic disparities, and geographic isolation, no single layer meets all targets (latency, coverage, capacity, cost, resilience).

Therefore, mixing layers lets the network hit target Key Performance Indicators (KPIs) while staying economical and robust. However, the key question is how the terrestrial network (TN) and the non-terrestrial network (NTN) will work together. What are the enabling technologies? How about the employment strategy? And are there any associated challenges?

The objective of this white paper is to present a fresh perspective on HAPS' role beyond traditional narratives from the prism of 3Cs (**Competition/ Complementarity/Collaboration**) [4]:



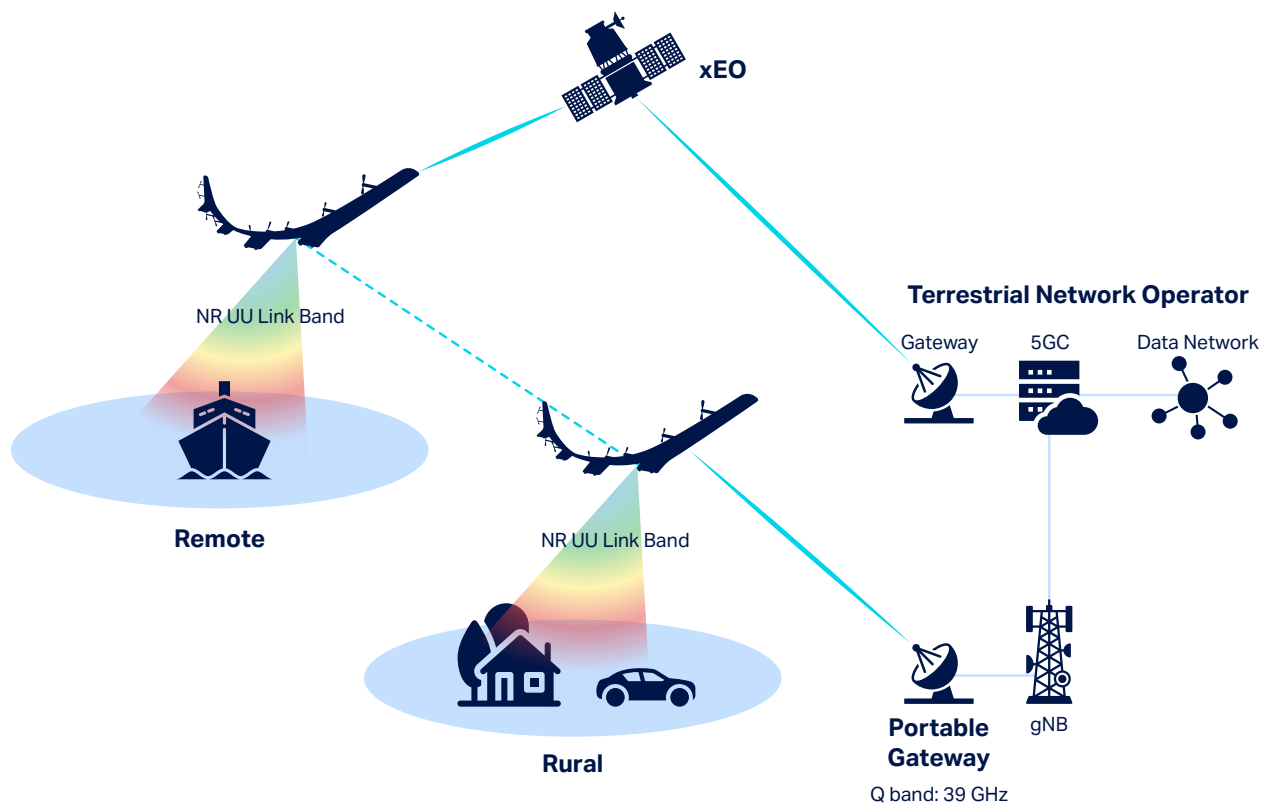
¹ <https://itwire.com/business-it-news/business-technology/white-paper-focuses-on-haps-advantages-over-satellites-for-connectivity.html>

² <https://spaceinfrica.com/2025/09/24/starlinks-market-share-in-kenya-declines-despite-subscriber-growth/>

1. HAPS and LEO satellites **compete** for the same access link in terms of latency, coverage, economics, and capacity; however, HAPS is the preferred choice from the perspective of latency and cost-sensitivity. On the other hand, LEO satellites are well-suited for wide-area coverage and higher data throughput.
2. HAPS and LEO satellites can also **complement** each other, either by offering unique services or covering distinct regions that others cannot do optimally. For instance, HAPS is ideal for covering small dense regions, while LEO satellites are appropriate for covering vast regions with sparse populations.
3. Alternatively, HAPS and LEO satellites can form a layered structure to **collaborate** and serve the same region by distributing load or sharing access and backhaul responsibilities. For instance, HAPS can provide access links to ground users, while LEO satellites provide backhaul to HAPS, or HAPS can act as an intermediate relay node between ground users and satellites.

Please refer to the figure below, which illustrates the backhaul architectures.

HAPS Backhaul Scenarios



When HAPS is deployed in rural or offshore areas, the backhaul link is typically supported by a ground gateway that uses a phased-array antenna operating in the Q/V band. In contrast, when HAPS provides service in remote regions or over the sea, the backhaul link is established via satellite. In such cases, a phased array antenna is also required to track satellites operating in the Ku/ Ka band.

The cross-cutting drivers for the 3Cs include performance diversity, economic pragmatism, resilience/ security demands, 6G/NTN evolution, access/backhaul bottlenecks, and regulatory reality. Moreover, Toka et al. detail the techno-economic considerations of LEO and HAPS, with the objective of integrating the skies for 6G [3].

Candidate\ Capability	Coverage Diameter	Data Throughput	Latency (ms)	Economics (CAPEX/OPEX) Annual in USD	Product Developmental Stage
HAPS	100 km	Up to 0.1Gb/s	1-5	0.23M	Development & Introduction
LEO	500 km	Up to 1Gb/s	10-50	0.26M	Mature

TBS-HAPS-LEO: From Cooperation to Complementarity & Competition

The synergistic operation of TBS, HAPS, and LEO satellites in 6G/NTN frameworks requires clear definitions of the 3 Cs: Collaboration/Complementarity/Competition [4]. It further highlights the ways (approach/methodology), means (pre-requisites/requirements), and ends (deliverables) for a certain deployment category.

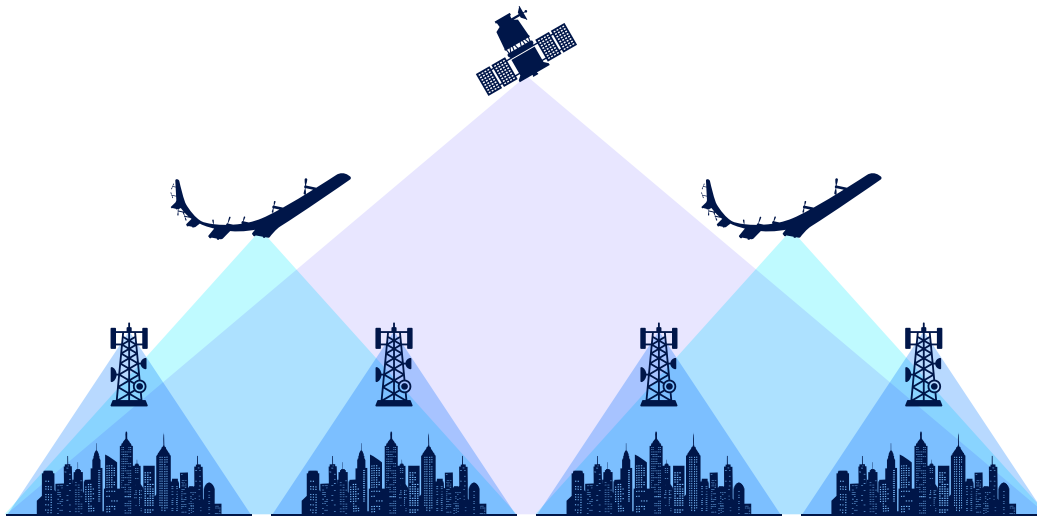
Cooperation (Joint, co-designed multi-layer operation)

In a cooperative framework, TBS, HAPS, and LEO work together to provide direct-to-device connectivity across a large coverage area. This leverages the benefits of each layer of the infrastructure.

- **Methodology:** It can be achieved by multi-layer cooperation between terrestrial, aerial, and space layers. We can stack (a) TBS for dense urban coverage for high capacity and low-latency local service, (b) HAPS for rapid coverage expansion and mobility augmentation, and (c) LEO satellites for global backhaul and resilience [4]. This framework enables cross-layer orchestration using AI-driven software-defined networking (SDN) or network function virtualization (NFV), and coordinated scheduling to dynamically route traffic across layers

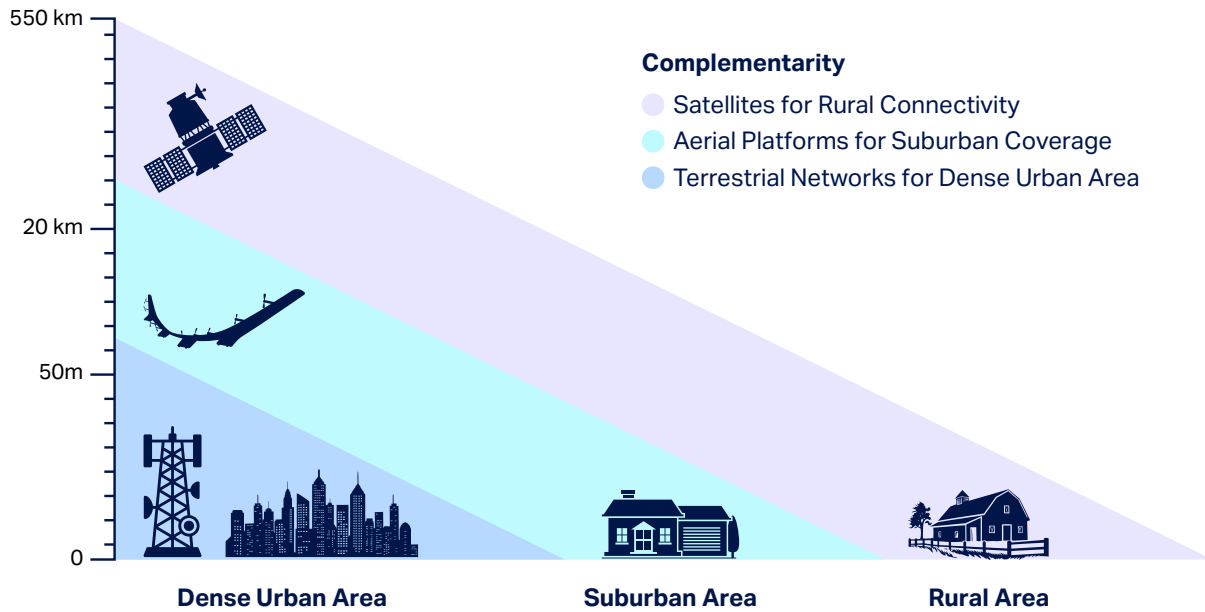
for optimal load sharing and seamless handovers. It also supports inter-layer frequency coordination and interference mitigation for efficient spectrum management. **Pre-requisites:** The multi-layer nodes will require standardized protocols (3rd Generation Partnership Project (3GPP) NTN and International Telecommunication Union (ITU) frameworks) to ensure seamless interoperability. The infrastructure also needs to be updated to introduce NTN compatibility in TBS, regenerative payloads in HAPS, and phased-array antennas on LEO satellites. Moreover, efficient resource management algorithms will empower predictive routing, congestion control, latency optimization, and quality of service (QoS) assurance.

- **Deliverables:** This framework will deliver ubiquitous connectivity from dense urban to remote regions ensuring latency optimization (HAPS for time-critical applications and LEO for high-capacity backbone), improved availability (hybrid free space optics (FSO)/radio frequency (RF) backhaul), mobility support (high-speed users connect to HAPS instead of TBS), service continuity (seamless handovers), compatibility (standard handsets), and cost effectiveness (no dense TBS for hard-to-reach /sparse areas). The network resilience in this mode ensures service continuity even if a layer is unavailable (e.g., damaged TBS or a congested HAPS), with multi-layer backup support.



Complementarity (distinct roles, loosely coupled)

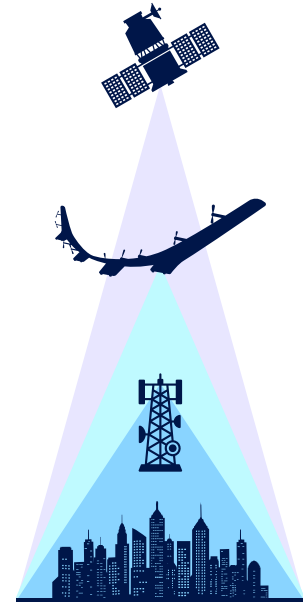
In the complementarity framework, all layers coexist in a disjointed manner based on functional differentiation. Each node plays distinct roles in either geographic zones (urban-TBS, suburban-HAPS, rural/remote-LEO) or service zones (TBS for Ultra-reliable low latency communications (URLLC)/ internet-of-things (IoT), HAPS for flash crowds/monitoring, and LEO for navigation/surveillance/broadcasting), subject to its specialization [4].



- **Methodology:** Achieved by leveraging a user’s location-based needs and the demand profile in a particular area, and assigning the layer that performs best. For instance, TBS for dense urban broadband connectivity, HAPS for regional hotspots/mobility corridors, and LEO for wide area sparse coverage. Likewise, service differentiation across nodes would enable matching consumer requirements to the most suitable layer.
- **Pre-requisites:** Complementarity requirements and /service demands to implement cloud-based traffic routing and zone allocation (distinct geographic or service zones for node deployment/assignment). User devices that require specific services must support multi-band/multi-mode capabilities (TBS/HAPS/LEO). Moreover, spectrum and policy alignment are essential for coordinating across TN and NTN to prevent overlap and interference between layers [5].
- **Deliverables:** The complementary framework ensures optimal use of each layer avoiding overbuilding by allowing each node to handle its niche. This reduces the redundancy and deployment cost in rural/remote regions while maximizing returns in dense zones. In particular, users experience enhanced QoS by receiving the right service from the right platform.

Competition (either HAPS or LEO for the same use case)

TBS densification is the preferred choice for reliable connectivity in dense urban areas. On the other hand, LEO is well-suited to deep rural areas due to its wider footprint. However, the main competition arises in suburban areas where TBS renders low-latency communications yet a costly expansion, LEO satellites offer wider coverage but suffer from over-subscription (leading to lower user density capacity and higher charges), and HAPS competes as an optimal KPI-compliant option in terms of latency, cost, coverage, throughput, and direct-to-device reach [4].



- Methodology:** This framework relies on demand-driven selection, where users/operators choose among TBS, HAPS, and LEO based on coverage, cost, and QoS requirements. It allows them to select the best-performing layer competing for the same service region without imposed coordination.
- Requirements:** Network operators need to design pricing and policy models to attract users by offering competitive pricing and service-level agreements. Healthy inter-layer competition demands spectrum policy and independent investments from mobile/HAPS/satellite operators.
- Deliverables:** Competition introduces a user-centric approach and market competition (spanning innovation, service diversity, cost reduction, performance improvement). Each region receives the most efficient service aligned within the target KPIs, prompting each operator to leverage its strengths.

3C Framework	HAPS	LEO Satellites	Terrestrial BS (TBS)
Competition	Low latency (~1–10 ms), regional coverage, cost-effective for hotspots	Higher latency (~20–60 ms), costly mega-constellations, global reach, including oceans	URLLC (~1 ms), high capacity, limited coverage, infrastructure-intensive
Complementarity	Fills coverage gaps in suburban/rural zones, offloads LEO/TBS traffic	Ensures global access in remote/maritime regions, provides resilience	Ultra-dense urban areas, backbone for massive connectivity & throughput
Cooperation	Acts as agile backhaul/mid-layer, rapid deployment, integrates in multi-layer NTN	Provides a global backbone, enabling seamless integration with HAPS/TBS via orchestrated handovers	Provides edge computing, local caching, and user proximity, anchors NTN integration with HAPS/LEO

Enabling technologies

The table presents a clear crystallization of enabling technologies across Cooperative, Complementary, and Competitive modes of TBS–HAPS–LEO integration:

Enabling Technologies	Cooperative Mode (integrated layers)	Complementary Mode (layer covers its niche)	Competitive Mode (Layers compete)
Frequencies (FSO/ RF/mmWave)	Multi-band operation, dynamic spectrum sharing, hybrid RF/FSO backhaul	Frequency partitioning by domain (TBS = sub-6GHz, HAPS = mmWave, LEO = Ka/Ku/FSO)	Independent spectrum allocations, KPI-driven frequency selection for cost/latency advantages
Antenna Design	Phased-array, steerable multi-beam antennas for seamless inter-layer handovers	Adaptive antennas optimized for specific urban/rural/sparse zones. (LEO=Wider beams, HAPS=Narrower Beams)	Antenna systems optimized per platform (TBS = small cells, HAPS = steerable beams, LEO = phased arrays)
Architectures (Cellular, Ad-hoc, Cell-free, IAB)	Integrated cellular + integrated access and backhaul (IAB) with SDN/NFV orchestration across all layers	Partitioned coverage: TBS = urban grids, HAPS = hotspots, LEO = sparse/remote, possible cell-free overlays	Independent cellular networks, no enforced integration, market/KPI-driven access
Payloads	Regenerative payloads on HAPS/LEO for onboard processing and inter-layer traffic management	Specialized payloads per platform (HAPS = Environmental sensors, LEO = Surveillance/Imaging Modules TBS = metro capacity communication module)	Differentiated payloads used as competitive advantage (HAPS = LoS direct-to-device, LEO = inter-satellite routing, TBS = dense MIMO)

Employment Strategy

The employment strategy outlines a use-case-driven analysis to determine the most suitable integration role within 3Cs. The role selection criterion is dictated by the latency, jitter, Doppler, coverage scale, population density, congestion, geographic accessibility, flexibility/scalability, deployment time, terminal constraints, and KPIs.

Use Cases and Focus Applications

Several use cases are presented to identify the most suitable role within the 3Cs based on the most critical requirement [4].



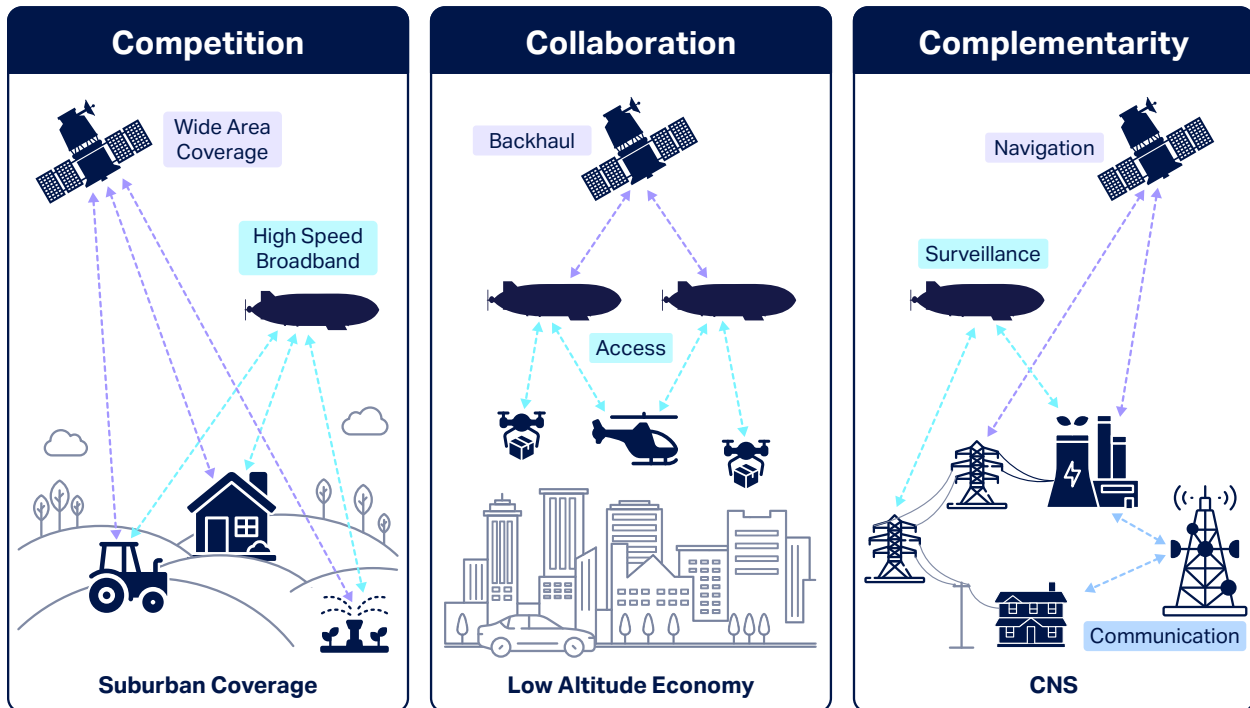
1. **Emergency communications** (requires rapid deployment): **Complementarity:** HAPS deliver broad, direct-to-device, pop-up coverage within hours to days, while LEO satellites can provide backhaul when terrestrial networks are impaired. Each platform complements the other to ensure continuous service.
2. **Tactile networks** (demand ultra-low latency): **Complementarity** – This use case requires ultra-low latency and reliability from localized, trusted nodes. HAPS can provide consistent, regionalized links, while TBS handles dense local access. LEO may provide encrypted long-haul links, but they are not suitable for ultra-low-latency and reliability requirements. Load sharing allows tactile-grade performance.
3. **Flash crowds** (demand temporary links): **Complementarity** – HAPS can conveniently cover hotspots, relieving TBS congestion and allowing it to focus on routine traffic. Moreover, LEOs can support broadcast or traffic offloading beyond the HAPS footprint. Complementarity allows scaling without overbuilding TBS.

4. **High-frequency trading** (requires ultra-low latency): **Complementarity** – TBS is the preferred choice for local access at trading hubs, while HAPS operate as near-fiber latency relays across regional corridors. LEO is the least effective due to latency constraints.
5. **Under-privileged** (demands economic coverage): **Competition** – TBS is too costly to roll out in low-ARPU villages. However, HAPS and LEO compete to provide low-cost coverage, despite LEO's higher terminal costs.
6. **Frequently shifting populations** (demands flexibility/mobility): **Competition** – HAPS is the preferred choice in dynamic settings with shifting populations (near the town center during the day and toward residential areas at night) owing to its flexibility and mobility, versus costly terrestrial densification across the area.
7. **White spot reduction** (demands lack of infrastructure): **Complementarity** – Remote locations such as maritime, aviation, mountainous, or desert can be covered by the global LEO satellites, while HAPS covers the regional corridors³, and TBS offers local access in coasts and airports.
8. **Deep rural areas/greenfield coverage** (demands wider coverage): **Complementarity** – Satellites can cover deep rural areas due to the larger coverage area and minimum capacity requirements, where the TBS exhibits limited or no feasibility. Complementary layering efficiently fills rural gaps.
9. **Suburban broadband** (demands QoS assurance): **Competition** – TBS can offer fiber-like speeds but requires dense ground rollout. Alternatively, HAPS competes as a regional broadband provider with cheaper deployment rates. In contrast, LEO competes by advertising high throughput, but the capacity saturates quickly in the suburbs.
10. **Dense urban areas** (demand blind spots coverage): **Collaborative** - Metropolitan cities can utilize the integrated TBS-HAPS-LEO layers to defeat coverage holes collaboratively. TBS leaves blind spots due to blockages and shadowing, whereas HAPS can cover these due to their LoS links
11. **Smart Cities** (demands URLLC and resilience): **Cooperation** – TBS handles dense IoT and vehicular communications for IoT connectivity and autonomous driving applications. HAPS adds elevation diversity and cell-free macro-panels for city-wide coordination, while LEO supplies resilient backhaul and synchronization across the metro area. The cooperation from all three nodes ensures zero blind spots and ultra-reliability for delay-sensitive applications.

³ https://hapsalliance.org/wpcontent/uploads/formidable/12/2025_HAPSAlliance_Reference_Architecture_Advantages_Satellite_Connectivity_TWG_Whitepaper.pdf

12. **Strategic Uses** (demands secure and assured communications): **Competition** – TBS is vulnerable to infrastructure damage (through a deliberate act or natural disaster), whereas LEO satellites are susceptible to jamming, spoofing, and even anti-satellite inventory because of their predictable orbits. However, HAPS competes with existing technologies by offering secure, assured regional and wide-area communications in such scenarios.

It is important to highlight that the preferred choice of the Collaboration/Complementarity/Competition framework in any use case scenario is based upon the key requirements, and it may opt for other modes as a fall-back position. In most scenarios, these technologies are more complementary than competitive, each addressing unique challenges and opportunities in the pursuit of seamless global connectivity.



Focus applications highlight the role of HAPS well beyond basic communications. HAPS – being sui-generis – is capable of rendering the following dividends:

CNS & Remote Sensing/Imaging (Cooperation)

In a collaborative setting, HAPS can provide persistent regional communication, navigation, and surveillance with low-latency and reduced bandwidth (with edge pre-processing). It can also support high-resolution regional imaging with existing optical technologies. However, it cannot replace the Global Navigation Satellite System (GNSS) offered by satellites.

Beyond Connectivity: (Complementarity)

Distributed Edge Processing can be performed on HAPS, while LEO provides elastic backhaul. The dual-stack backhaul balances capacity (FSO) and weather resilience (RF)

Environmental Monitoring (Cooperation)

Climate monitoring and remote sensing can be retrieved from HAPS sensors and transmitted to LEO, ensuring global distribution/storage. This fills the gap beyond the HAPS footprint.

Agricultural Support (Complementarity)

In regions with sustained demand for precision farming, a few HAPS can outperform LEO on cost/latency when using IMT/HIBS access and standard handsets. Where fiber is sparse, HAPS access and LEO backhaul keep opex low.

Low-Altitude Economy (Cooperation)

The connectivity, collision avoidance, and trajectory planning for electric Vertical Take-Off and Landing (eVTOL) and unmanned aircraft systems (UAS) can be performed using HAPS regional command and control powered by multi-access edge computing (MEC). LEO extends backhaul connectivity or inter-city/oceanic continuity; terrestrial small cells add street-level capacity where available.

Challenges in the Realization of triple C's

Challenges in the realization of the triple C range from technical and legal to administrative and infrastructure-based, as well as from being a new entrant in the market [4]. However, given the confines of the 3Cs structure, they can be categorized as follows:

1. **Collaboration:** One of the major challenges in implementing a cooperative TBS-HAPS-LEO network is the lack of a standardized policy across operators/layers to harmonize efforts. HAPS Alliance is instrumental in endorsing regulatory reforms⁴ and certifications⁵ to realize the true potential of HAPS. The integrated cooperating layers also face limitations in terms of load balancing, interference management, and Doppler Shift. Dynamic traffic steering among TBS-HAPS-LEO requires AI-based orchestration to avoid service dropouts. It also requires effective interference management to address cross-layer interference across the spectrum during handovers, as beams from TBS-HAPS-LEO overlap. Moreover, fast-moving

⁴ https://hapsalliance.org/wpcontent/uploads/formidable/12/HAPS_Alliance_TWG_Regulatory_Positions_Paper_2024.pdf

⁵ https://hapsalliance.org/wp-content/uploads/formidable/12/HAPS_Certification_Pathways_2024-3.pdf

LEO satellites and station-keeping (heavier-than-air)/drifting (lighter-than-air) HAPS cause frequency shifts, disrupting precise tracking and synchronization.

2. **Competitive:** When TBS, HAPS, and LEO compete for the same user and market, it is difficult to ensure fair competition, as each has different CapEx/OpEx, area throughput, footprint, and lifespan. Likewise, spectrum licensing gives rise to conflicts among mobile operators, HAPS providers, and satellite operators. Moreover, it is extremely difficult to crystallize service quality differentiation, as it spans numerous KPIs: TBS offers the best latency, but not everywhere; HAPS offer flexible deployment but limited operational time; and LEO claims global reach but reports congestion in cities. In addition, the lack of universally accepted devices limits fair competition, as customers may be unwilling to purchase separate user terminals.

3. **Complementarity:** The divide-and-conquer approach presents inherent challenges. For example, defining/managing clear boundaries between geographic zones, policy making for layer selection by location/load/service requirement, seamless inter-layer handoffs, QoS translation in terms of different KPIs across layers, spectrum partitioning, backhaul alignment, central command and control to observe KPIs per layer, and simultaneous regulatory constraints on power, altitudes, and beams for terrestrial, airspace, and satellite operation [4]. Moreover, service complementarity requires different payload capabilities, such as software-defined radio (SDR) for communications and synthetic aperture radar (SAR) for surveillance, at each node.

Spectrum Allocation Efforts Feeder/ access frequency band. HAPS in fixed services	Network Integration Efforts HAPS coexisting with satellites & terrestrial networks in B5G/6G.	Aviation Regulation Efforts Licensing, safety, & airspace.
<ul style="list-style-type: none"> • WRC-19 agreed 31–31.3 & 38-39.5 GHz, and refinements in 47.2-47.5 /47.9-48.2 GHz for HAPS UL/DL feeder; AI 1.14 [6] • HAPS as IMT base stations – WRC-23 expanded to 0.7-0.9/ 1.7/ 2.6GHz (agenda item AI 1.4), enabling seamless integration with smartphone etc. [7]. 	<ul style="list-style-type: none"> • ITU-R (WP 5C) presented sharing/ compatibility studies (F.2437-39) to protect existing services [8] • 3GPP-17 claims HAPS as NTN, 3GPP-18 sets HAPS as IMT station (HIBS) [9], and upcoming 3GPP-19 is expected to address its integration with 6G network [10] 	<ul style="list-style-type: none"> • ITU-RR, HAPS radio station, 20-50km altitude [11]. • NASA regularizes HAPS communication in Wild-Firefighting [12], coastal surveillance [13], R&D [14] • HAPS alliance: pursues FAA/ EASA certifications for world-wide operations, supports ICAO for HAPS global aerial integration [15]

Conclusion

The communication landscape is evolving rapidly from the perspectives of users and the communication network, including both NTN/TN. The 3Cs framework of Cooperation, Complementarity, and Competition provides a holistic lens for understanding the interactions among TBS, HAPS, and LEO satellites with the aim of delivering a multi-layered, resilient, and adaptive communication ecosystem. Each mode contributes uniquely to the architecture: cooperation maximizes resilience, redundancy, and the elimination of blind spots; complementarity ensures scenario-driven (i.e., based on spatial/ service demands) optimal utilization of resources; while competition accelerates healthy competition for being the best service provider.

Nonetheless, despite its significant potential to deliver breakthrough dividends, implementing this 3Cs model is an uphill task that faces non-trivial technical and regulatory challenges. These mainly include, but are not limited to, 1) Standardization between NTN-TNs to achieve Collaboration; 2) Delineation of dynamic boundaries from the prism of geographical and service zones to attain Complementarity, and 3) KPI based AI-driven service provider selection to play the Competition.

Forecasting the future, NTN-TN convergence through the proposed 3Cs paradigm is set to accrue not only the transformation of how communication networks and connectivity are perceived in today's world, but also the strategic dividends cutting through the domains of communication science and well into technology integration, economic-education boom, as well as security domains, etc.

Finally, if the host of actors, including academia & research, relevant government bodies, and industry, collaborate while putting a premium on state-of-the-art deployable and observable research and development (R&D), desired multi-domain effects can be reaped in medium to long-term, well beyond the currently imaginable frontiers.

List of Acronyms

Acronym	Description	Acronym	Description
TBS	Terrestrial BS	AR	Augmented Reality
HAPS	High-Altitude Platform Stations	VR	Virtual Reality
LEO	Low Earth Orbit	XR	Extended Reality
CapEx	Capital Expenditure	KPIs	Key Performance Indicators
OpEx	Operational Expenditure	TN	terrestrial network
HD	High Definition	NTN	non-terrestrial network
6G	Sixth generation	3GPP	3rd Generation Partnership Project
AI	Artificial Intelligence	ITU	International Telecommunication Union
SDN	Software-defined Networking	WRC	World Radiocommunication Conference
NFV	Network function virtualization	WP	Working Party
QoS	Quality-of-Service	RR	Radio Regulations
FSO	Free Space Optics	IMT	International Mobile Telecommunications
RF	Radio Frequency	URLLC	Ultra-reliable low latency communications
mmWave	Millimeter wave	NASA	National Aeronautics & Space Administration
UAS	unmanned aircraft systems	IAB	Integrated Access and Backhaul
IoT	Internet of Things	MIMO	Multiple input and multiple output
MEC	multi-access edge computing	ARPU	Average Revenue Per User
SDR	Software-Defined Radio	LoS	Line-of-sight
SAR	Synthetic Aperture Radar	GNSS	Global Navigation Satellite System
UL/DL	Uplink / Downlink	eVTOL	electric Vertical Take-Off and Landing
HTA/LTA	Heavier/lighter than air	HIBS	HAPS as IMT Base Station
ESA	European Space Agency	R&D	Research and Development
FAA	Federal Aviation Administration	ICAO	International Civil Aviation Organization

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